Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/146
UNITED KINGDOM
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

DEVELOPMENT OF MAGNESIUM ALLOYS FOR FUEL ELEMENTS IN THE UNITED KINGDOM

by

+ P. Greenfield
* R. G. Coffin
= G. C. E. Olds
ß B. Pickles
xx T. C. Wells

For British civil reactors Magnox AL80 has been employed extensively for fuel element canning and structural components. To meet more stringent operating conditions and greater fuel element burn-up requirements, magnesium alloys have been developed with high creep strength and adequate ductility at reactor temperatures whilst having a neutron capture cross section of the same order as that of AL80. In addition, the properties of the magnesium-zirconium alloy ZA have been extensively investigated in order to assess its suitability as a canning material.

The work on ZA has shown that in most respects the properties of this alloy are superior to those of AL80 when considered for canning purposes. Diffusion of plutonium through ZA can walls during reactor service, however, would lead to early discharge of ZA canned elements. Interlayers between can and fuel are being examined in order to prevent such diffusion. Diffusion of plutonium does not occur in AL80 and burn-ups up to 5,470 MWD/Te maximum have been achieved using fine grained AL80 cans.

+ English Electric Company, Whetstone, Leicester.
* United Power Company, R. and D. Laboratories, Hounslow.
= Associated Electrical Industries Central Research Laboratory, Rugby.
ß United Kingdom Atomic Energy Authority, Culcheth.
xx International Research and Development Company Ltd., Newcastle.

Heat treatment of ZA for 96 hours at 600°C produces a marked increase in the creep strength of the material and renders it suitable for use as splitters and braces in which high creep strengths rather than high ductilities are required. Zirconium containing magnesium alloys, however, are not metallurgically stable in moist carbon dioxide, zirconium hydride being precipitated by reaction with moisture. Such precipitation could lead to changes in properties during service and this has led to the examination of pre-hydrided ZA which is not susceptible to further modification in properties due to hydriding during reactor operation. The properties of pre-hydrided ZA are markedly affected by the stage in manufacture at which the hydriding takes place but it has been shown that WHP ZA (extruded, homogenised for 96 hours at 600°C, hydrided) has a much higher creep strength than ZA heat treated in any other way.

Additions of manganese to ZA produce further improvements in creep strength and both Magzan 2, containing 0.1 - 0.2% manganese and Magzan 4, containing about 0.4% manganese, have been investigated. Both of these alloys contain precipitated phases and Magzan 4 has not yet been produced with satisfactory homogeneity. Most attention has therefore been given in Magzan 2 which gives an excellent combination of high strength and ductility with a fine, stable grain size.

For end caps, in which the volume of material is small and consequently the neutron capture cross-section comparatively unimportant, Mg-Mn alloys containing 0.5 - 1.5% manganese have been investigated. In these alloys particularly, grain size plays a very large part in determining the creep properties, a grain coarsening treatment effecting improvements in creep strengths but lowering ductilities. With the higher manganese alloys, however, good combinations of high strength, ductility and moderate grain size can be achieved.

Preliminary investigations on magnesium alloys manufactured from powder indicate that these can be produced with a very high level of creep strength and adequate ductility in short term tests but much remains to be done both in improvement of production methods and determination of their properties.